No. 884,986. PATENTED APR. 14, 1908.

G. MARCONI.

WIRELESS TELEGRAPHY.

APPLICATION FILED NOV. 28, 1902.

Fig. 1.

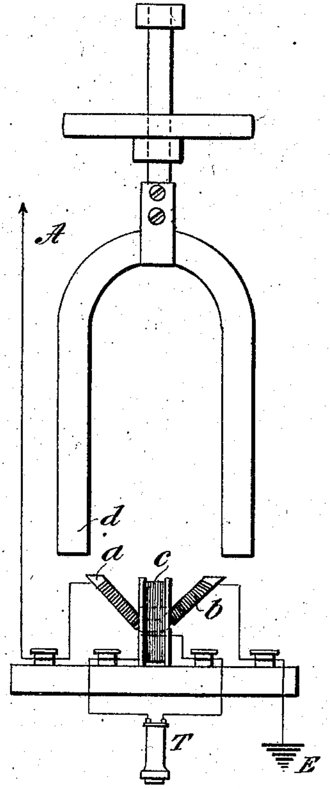


Fig. 2.

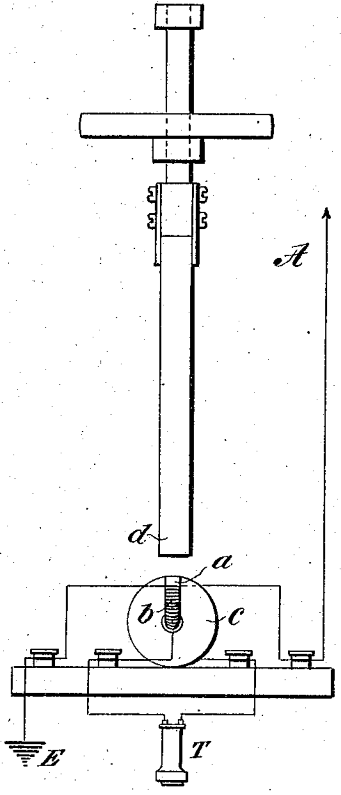


Fig. 3.

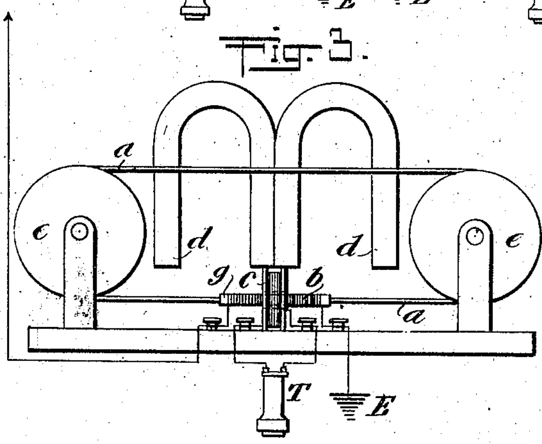
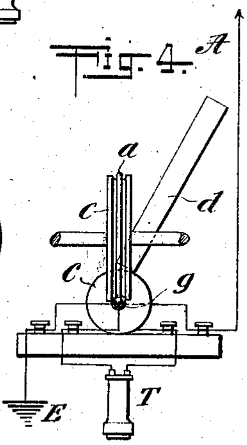


Fig. 4.



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UNITED STATES PATENT OFFICE.

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WIRELESS TELEGRAPHY.

No. 884,986. Specification of Letters Patent. Patented April 14, 1908.

Application filed November 28, 1902. Serial No. 132,974.

To all whom it may concern:

Be it known that I, GUGLIELMO MARCONI, a subject of the King of Italy, residing at 18 Finch Lane, in the city of London, England, electrician, have invented certain new and useful Wireless Telegraphy, of which the following is a specification.

This invention is based upon the discovery that a core or rod of magnetic material which is not sensibly affected by high frequency electrical oscillations or Hertzian waves under ordinary circumstances, becomes sensitive to them when placed in a varying or moving magnetic field.

My present theory of the action of the apparatus hereinafter described is as follows, although I intend to claim this apparatus broadly, whether this theory is correct or not:—It is a well known fact that after any change has taken place in the magnetic force acting on a piece of iron, some time elapses before the corresponding change in the magnetic state of the iron is completed. If the applied magnetic force be either subjected to a gradual increase followed by an equally gradual diminution or caused to effect a cyclic variation, the corresponding induced magnetic variation in the iron will lag behind the changes in the applied force. To this tendency to lag behind, Prof. Ewing has given the name magnetic hysteresis. It has been shown also by Gerosa, Finzi, and others that the effect of alternating currents or high frequency electrical oscillations acting upon iron, is to reduce considerably the effects of magnetic hysteresis, causing the metal to respond much more readily to any influence which tends to alter its magnetic condition. The effect of electrical oscillations probably is to bring about a momentary release of the molecules of iron from the constraint (or viscosity) in which they are ordinarily held, diminishing their retentiveness and consequently decreasing the lag in the magnetic variation taking place in the iron. I, therefore, anticipated that the group of electric waves emitted by each spark of a Hertzian radiator would, if caused to act upon a piece of iron which is being subjected at the same time to the slowly varying magnetic force, produce sudden variation in its magnetic hysteresis, which variations would produce others of a sudden or jerky nature in its magnetic condition. In other words, the magnetization of the iron, instead of slowly following the variations of the magnetic force applied, would at each spark of the transmitter suddenly diminish its magnetic lag caused by hysteresis. These jerks in the magnetic condition of the iron would cause induced currents in a coil of wire of strength sufficient to allow the signals transmitted to be detected intelligibly on a telephone, or perhaps even read on a galvanometer. The jerks in the magnetic condition of the iron might also be detected by a telephone diaphragm applied directly thereto.

On a core consisting of some magnetic material which may be iron, preferably in a subdivided state, such as fine wires or needles, is wound one or several layers of insulated copper wire. Over this winding is placed insulating material and over this a secondary winding of thin copper wire contained in a narrow bobbin. The ends of the winding nearest to the iron core are connected one to earth or to a capacity and the other to an elevated conductor, or they may be connected to the secondary of a suitable transformer or intensifying coil. The ends of the secondary winding are connected to the terminals of a telephone or other suitable receiving instrument. The secondary winding may, however, be omitted and the magnetic changes in the iron core detected by placing the telephone diaphragm in immediate proximity to the said core or by any other suitable means. At the ends of the core or in close proximity to it is placed a magnet which is so moved or revolved as to cause a constant change or successive reversals in the magnetization of the iron core.

It is found that if the electrical oscillations of suitable period are sent from the transmitting station according to the now well known methods, rapid changes are effected in the magnetization of the iron core, which changes produce induced currents on the winding, and these currents in their turn reproduce on the telephone or receiving instrument the intelligible signals sent from the transmitting station. Another successful method is to keep the magnet fixed and use an endless iron rope or core of thin wires revolving on pulleys through the windings (which in this case are separated from the iron by means of a thin glass tube to prevent chafing of the wires) in proximity to a magnet or magnets.

Figures 1 and 2 are diagrammatic front and side elevations of the arrangement. Figs. 3 and 4 are similar views of a modification.

a is the core the ends of which, in Figs. 1 and 2, are bent upwards and consisting of about 30 hard-drawn iron wires of about .5 mm. in diameter. Over this a primary winding of one or two layers of thin silk covered wire *b* is placed, one end being connected to a capacity E which may be the earth, and the other to the aerial conductor A. The wire of the secondary winding *c* is about .02 cm. in diameter and a sufficient number of turns of it is used to give a resistance about equal to that of the telephone T to which its ends are connected.

d is a horseshoe magnet driven round by a clockwork mechanism at a speed of about one revolution per second or other suitable speed.

Figs. 3 and 4 show the arrangement where a continuous band or metal rope is used. In this case two stationary horseshoe magnets *d d* are used which should be arranged with their like poles together. The core *a* is flexible and passes around two pulleys *e* which are about 10 cm. in diameter and are placed about 20 cm. apart. They are driven by clockwork at about the speed of one revolution every two seconds or other suitable speed. *g* is a glass tube on which the primary *b* is wound and through which the core *a* passes. The other parts are similar to those of the former arrangement.

Either iron or steel can be used for the cores or revolving rope, but best results have been obtained when using hard drawn iron wire or iron wire which has been considerably stretched and twisted beyond its limits of elasticity prior to being employed.

The telephone or receiving instrument T may be connected to the ends of the winding *b* nearest the iron and the other winding *c* be omitted, or the iron core *a* may be placed in close proximity to a telephone diaphragm and the sudden changes of magnetism in the core can then be detected by sounds produced by the diaphragm. In this case also no second winding is required on the core.

The form of apparatus, as shown in Figs. 1 and 2, comprising a fixed core and movable magnet, is not herein especially claimed, but constitutes the subject-matter of an application, Serial No. 141,398 filed as a division of my present application.

What I claim is:

1. At a receiving-station in a wireless telegraph system, the combination of a core of magnetic material, means for producing a varying magnetic field in said core, and means inductively affected by the core for receiving oscillations, substantially as described.

2. At a receiving-station in a wireless telegraph system, the combination of a core of magnetic material, means for producing a varying magnetic field, a coil surrounding the core, and means for causing the received oscillations to pass through the coil, substantially as described.

3. At a receiving-station in a wireless telegraph system, the combination of a core of magnetic material, means for producing a varying magnetic field, a coil surrounding the core, means for causing the received oscillations to pass through the coil, a receiving instrument and a secondary coil likewise surrounding the core and having its ends connected to the receiving instrument, substantially as described.

4. At a receiving-station in a wireless telegraph system, the combination of a core of magnetic material, means for producing a varying magnetic field, a coil surrounding the core, an oscillation-receiving conductor connected to one end of the coil, and a capacity connected to the other end of the coil, substantially as described.

5. At a receiving-station in a wireless telegraph system, the combination of a core of magnetic material, means for producing a varying magnetic field, a coil surrounding the core, an oscillation-receiving conductor connected to one end of the coil, a capacity connected to the other end of the coil, a receiving-instrument and a second coil likewise surrounding the core and having its ends connected to the receiving instrument, substantially as described.

6. At a receiving-station in a wireless telegraph system, an oscillation-receiving conductor, a coil connected to said conductor, a core surrounded by said coil, and means for producing a varying magnetic field in the core, in combination with a receiving-instrument, substantially as described.

7. At a receiving-station in a wireless telegraph system, an oscillation-receiving conductor, a coil connected to said conductor, a core surrounded by said coil, and a magnet, and means for changing the relative positions of the core and the magnet for producing a varying magnetic field in the core, in combination with a receiving-instrument, substantially as described.

8. At a receiving-station in a wireless telegraph system, an oscillation-receiving conductor, a coil connected to said conductor, a core surrounded by said coil, a magnet, and means for moving the core through the field of said magnet, for producing a varying magnetic field in the core, in combination with a receiving-instrument, substantially as described.

9. At a receiving-station in a wireless telegraph system, an oscillation-receiving conductor, a coil connected to said conductor, a wire passing through the coil and constituting a magnetic core, a magnet placed near

said wire, and means for moving the wire through the coil, for producing a varying magnetic field in the wire, in combination with a receiving-instrument, substantially as described.

10. At a receiving-station in a wireless telegraph system, an oscillation-receiving conductor, a coil connected to said conductor, a core surrounded by said coil, means for producing a varying magnetic field in the core, and a receiving-instrument inductively affected by the core, substantially as described.

11. At a receiving-station in a wireless telegraph system, an oscillation-receiving conductor, a coil connected to said conductor, a core surrounded by said coil, means for producing a varying magnetic field in the core, and a receiving-telephone provided with a diaphragm inductively affected by the core, substantially as described.

12. At a receiving-station in a wireless telegraph system, an oscillation-receiving conductor, a magnetizable core constituting the armature of a magnetic field, connections whereby oscillations received by the receiving conductor affect the core, and means, operating independently of received oscillations, for varying the magnetic field aforesaid, substantially as described.

13. At a receiving-station in a wireless telegraph system, an oscillation-receiving conductor, a magnetizable core constituting the armature of a magnetic field, connections whereby oscillations received by the receiving conductor affect the core, means, operating independently of received oscillations, for varying the magnetic field aforesaid, and means, controlled by the core, for making received signals manifest, substantially as described.

14. At a receiving-station in a wireless telegraph system, an oscillation-receiving conductor, a permanent magnet, a magnetizable core placed within the field of said magnet, connections whereby oscillations received by the receiving conductor affect the core, and means, operating independently of received oscillations, for varying the magnetic field aforesaid, substantially as described.

15. At a receiving-station in a wireless telegraph system, an oscillation-receiving conductor, a magnetizable core constituting the armature of a magnetic field, connections whereby oscillations received by the receiving conductor affect the core, and a motor and means operated thereby for causing variations of the magnetic field aforesaid, substantially as described.

16. At a receiving-station in a wireless telegraph system, the combination of an oscillation-receiving conductor, a coil connected to said conductor, means for producing a magnetic field which includes said coil, and a receiving-instrument affected by said field, substantially as described.

17. At a receiving-station in a wireless telegraph system, the combination of an oscillation-receiving conductor, a coil connected to said conductor, means for producing a magnetic field which includes said coil, and a receiving-instrument inductively affected by said field, substantially as described.

18. At a receiving-station in a wireless telegraph system, the combination of an oscillation-receiving conductor, a coil connected to said conductor, means for producing a varying magnetic field, and a receiving instrument affected by said varying field, substantially as described.

19. At a receiving-station in a wireless telegraph system, an oscillation-receiving conductor, a coil connected to said conductor, a magnet for creating a magnetic field which includes the coil, and means for varying the magnetic field, substantially as described.

20. A receiver for electro-magnetic waves, having in combination, a core of magnetic material, means for maintaining the magnetization in the core in a constantly varying state, means for utilizing currents produced by electro-magnetic waves for abruptly altering such magnetization, and an indicating mechanism operative by such abrupt changes in magnetization, substantially as set forth.

21. A receiver for electro-magnetic waves, having in combination, a core of magnetic material, means for maintaining the magnetization in the core in a constantly varying state, and an indicating mechanism operative by abrupt changes in the amount of the magnetization produced by currents generated by electro-magnetic waves, substantially as set forth.

22. At a receiving-station in a wireless telegraph system, an oscillation-receiving conductor, a wave-responsive device electrically connected therewith, and a magnet, energized independently of the receipt of oscillations, for creating a magnetic field which includes the wave-responsive device, substantially as described.

23. At a receiving-station in a wireless telegraph system, an oscillation-receiving conductor, a wave-responsive device electrically connected therewith, and a magnet, energized independently of the receipt of oscillations, for creating a varying magnetic field which includes the wave-responsive device, substantially as described.

24. At a receiving-station in a wireless telegraph system, an oscillation-receiving conductor, a wave-responsive device electrically connected therewith, and means for constantly maintaining a magnetic field which includes the wave-responsive device.

25. In a receiver for wireless telegraphy, a magnet for creating a magnetic field, a mag-

netizable member located in said magnetic field, means for moving the magnetizable member with relation to the magnet for producing varying magnetism in the said member.

26. In a receiver for wireless telegraphy, a magnet for creating a magnetic field, a magnetizable member located in said magnetic field in proximity to the poles of said magnet and means for rotating the magnetizable member with relation to the poles of said magnet to vary its magnetism.

27. In a receiver for wireless telegraphy, a stationary magnet and a movable magnetizable member located in the field created by said magnet, whereby upon movement of the same the magnetic field produced by the magnet is varied.

28. In a receiver for wireless telegraphy, a magnet, a movable magnetizable member located in the magnetic field created by the said magnet, and means for creating changes of magnetism in the movable member, substantially as described.

29. In a receiver for wireless telegraphy, a stationary magnet, a magnetizable member located in the field created by said magnet, means for creating alternations or reversals of magnetism in the movable member, substantially as described.

30. At a receiving station in a wireless transmission system, the combination of means for producing varying magnetism in a magnetic body subjected to the action of the received oscillations, and means for detecting the change of magnetic conditions in said body caused by the received oscillations.

31. At a receiving station in a system for signaling by electrical oscillations of high frequency, the combination of an oscillation receiving conductor, means for creating a magnetic field independently of the received oscillations, means for varying said field by the said received oscillations and means responsive to the variations in said field for rendering received oscillations intelligible as signals.

GUGLIELMO MARCONI.

Witnesses:

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